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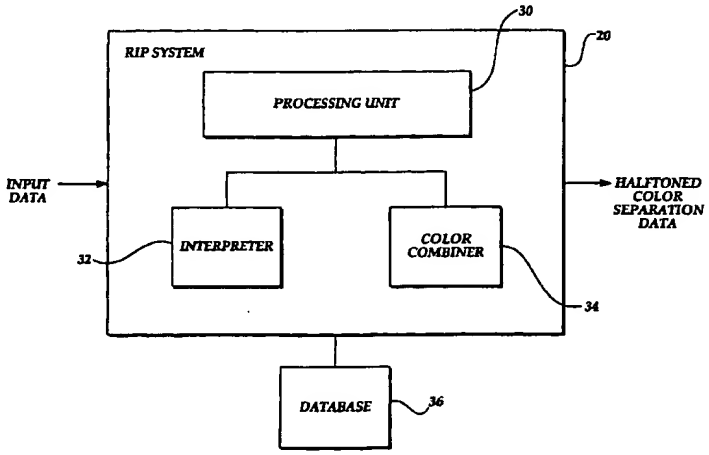
(54) Title: SYSTEM AND METHOD FOR PRODUCING HALFTONED COLOR SEPARATIONS FOR AN OUTPUT IMAGING DEVICE



(57) Abstract: A raster image processing system (20) for producing the appropriate number and set of halftoned color separations for a select output device (24) is disclosed. The raster image processing system (20) includes a processing unit (30), an interpreter (32) and a color combiner (34). The interpreter (32) and color combiner (34) are application processes that are controlled by software running on the processing unit (30). The processing unit (30) identifies the number and set of colorants used to describe input image data and the number and set of halftoned color separations that a select output imaging device (24) is capable of rendering. The interpreter (32) converts the input data describing an image that is composed of "N" colorants into "N" halftoned color separations. The color combiner (34) thereafter converts the N halftoned color separations into "M" halftoned color separations that are ideally suited for the particular output device (24) chosen by a user of the system. The color combiner (34) performs this conversion by utilizing digital filtering and combining processes.

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SYSTEM AND METHOD FOR PRODUCING HALFTONED COLOR SEPARATIONS FOR AN OUTPUT IMAGING DEVICE

Field of the Invention

This invention generally relates to a system and method for producing halftoned color separations from input data describing an image and, more particularly, to a system and method for producing halftoned color separations that are ideally suited for a specific output imaging device.

Background of the Invention

Traditionally, in the prepress field, input data describing an image, such as a PostScript input file, is transformed into at least one halftoned color separation which is ultimately either saved to a file or immediately sent to an output device for imaging. The transformation of the input data to at least one halftoned color separation is performed by a Raster Image Processor (RIP).

In particular, the RIP converts input data to bitmap data, which is required by output devices to render the image. In this regard, the RIP creates a bitmap image, i.e. a series of 1s and 0s, typically for each of the colorants used to compose the image, and hence, in this instance, the resulting bitmap is also called a "halftoned color separation" which is a 1 bit per pixel bitmap. When the input data is completely rasterized, the RIP transfers the bitmap data via a device driver to an output device which uses the information in the bitmap data to render the image. Alternatively, the RIP can store the bitmap data to a file for later importation into an output device.

Typically, if the input data identifies "N" colorants for composing the image, most RIPs receiving such input data produce "N" halftoned color separations, one for each colorant. However, a selected output device may only be capable of imaging

"M" halftoned color separations such that there is not a direct mapping from the N halftoned color separations to the M halftoned color separations. In order for a direct mapping to exist, all of the N colorants must be included in the set of colorants corresponding to the M halftoned color separations.

As an example, if N is greater than M and the N halftoned color separations include the specific set of M halftoned color separations, the output device images only the M halftoned color separations. Thus, the resulting image lacks any colors provided by the other of the N halftoned color separations which were not included in the set of M halftoned color separations and hence were not imaged by the output device. In particular, assume that the RIP produces five halftoned color separations representing process colors cyan, yellow, magenta and black (CYMK) and a spot color "cherry apple red." Also, assume that the output device is capable of imaging four halftoned color separations representing the process colors CYMK. In this case, the selected output device will only image the four halftoned color separations representing the process colors, i.e. the colors in common between the sets of halftoned color separations. Thus, any objects in the image described in the spot color will not be provided in the output from the imaging device.

As another example, if N is equivalent to M and the specific halftoned color separations produced by the RIP and required by the output device are identical, i.e. there is a direct mapping from the N halftoned color separations to the M halftoned color separations, the result from the output device most accurately describes the original image since all of the halftoned color separations provided by the RIP are imaged by the output device. However, in this example, if the specific halftoned color separations are not identical, the output device will only image those colors represented by halftoned color separations that the output device has in common with the ones provided by the RIP.

Some RIPs try to resolve the negative results described above by internally converting the halftoned color separations that it produces into the appropriate number and set of halftoned color separations for a select output device. However, presently, when these converted color separations are applied to the output device, the output therefrom does not accurately reflect the original content used to compose the image. Some colorants may be missing or misrepresented with respect to overprints or knockouts.

As a result, there is a need for a system and method that produces the appropriate number and set of halftoned color separations for a select output device such that the resulting image more accurately reflects the original.

Summary of the Invention

In accordance with the present invention, a raster image processing system automatically produces the appropriate number and set of halftoned color separations for a select output device. The raster image processing system includes a processing unit, an interpreter and a color combiner. The interpreter and color combiner are application processes that are controlled by software running on the processing unit. The processing unit receives input data describing an image having "N" colorants and controls processes implemented by the interpreter and the color combiner. The processing unit identifies the number and set of colorants used to describe input image data and the number and set of halftoned color separations that an output imaging device is capable of rendering. The interpreter converts the input data describing an image having "N" colorants into "N" halftoned color separations. Then, the color combiner converts the N halftoned color separations into "M" halftoned color separations that are ideally suited for a particular output device as chosen by a user of the system. The color combiner performs this conversion by utilizing digital filtering and combining processes.

Before filtering and combining the halftoned color separations produced by the interpreter, the raster image processing system performs a database search to identify a set of filters to apply to each of the N halftoned color separations. In particular, the raster image processing system identifies tint percentages for each of the N halftoned color separations. The tint percentages identify the percentage contribution of each color that the output device is capable of imaging in each of the N halftoned color separations. Then, the raster image processing system dynamically computes the filters based on the tint percentages. The filters are bitmaps that, once created, are applied to the N halftoned color separations by performing a bitwise "AND" combination function therebetween to produced filtered halftoned color separations. Then, select filtered halftoned color separations are combined using a bitwise "OR" combination function such that the appropriate M halftoned color separations are produced. These M halftoned color separations are ideally suited for the selected output device to most accurately render the original image.

As will be readily appreciated from the foregoing description, the invention provides for a raster image processing system that produces M halftoned color

separations that are ideally suited for the selected output device to most accurately render the original image. Such a raster image processing system is capable of being used with numerous different output devices, each of which is capable of imaging a different number and/or types of colorants, and still produce the same image because the M halftoned color separations produced by the system are tailored to the specific output device selected by a user.

Brief Description of the Drawings

The foregoing aspects and many of the attendant advantages of this invention will become more readily appreciated as the same become better understood by reference to the following detailed description, when taken in conjunction with the accompanying drawings, wherein:

FIGURE 1 is a block diagram that illustrates a raster image processing system formed in accordance with the present invention in a prepress workflow environment;

FIGURE 2 is block diagram that illustrates the components of the raster image processing system of FIGURE 1 in accordance with this invention;

FIGURE 3 is a flow diagram illustrating the logic used by the raster image processing system of this invention to produce the appropriate halftoned color separations for a select output device;

FIGURE 4 is a flow diagram illustrating the logic used by a color combiner process of the raster image processing system of this invention;

FIGURE 5 is a block diagram that illustrates the color combiner component of the raster image processing system of FIGURE 2 in further detail;

FIGURE 6 is a block diagram that illustrates an example of the bitwise "AND" combination function performed when filtering halftoned color separations in accordance with this invention; and

FIGURE 7 is a block diagram that illustrates an example of the bitwise "OR" combination function performed on filtered halftoned color separation to produce the desired number and set of halftoned color separations for the select output device.

Detailed Description of the Preferred Embodiment

The present invention is a raster image processing (RIP) system and method that produces the appropriate number and set of halftoned color separations for use by a particular output device as selected by a user of the system.

FIGURE 1 illustrates a raster image processing (RIP) system 20 of the present invention that interfaces with an input device 22 and an output device 24. As

will be described in more detail below, the RIP system 20 receives and processes input data describing an image from the input device 22. The input device can be of any type that is used for creating and/or storing data that describes an image. Examples include a computer workstation, a server, a data storage medium, or the like. The data may be directly transferred to the RIP system upon creation or stored on a storage medium and later downloaded and transferred to the RIP system. An example of such stored data is a PostScript file. After processing the input data, the RIP system 20 outputs at least one halftoned color separation to the output device 24. As also further described below, the at least one halftoned color separation is ideally suited for the particular output device 24 such that the image rendered by the output device 24 adequately represents the original created by the input device 22. The output device can be of any type capable of rending an image. Examples include an image recorder, laser printer, platesetting device or the like.

FIGURE 2 illustrates the components of the RIP system 20 of the present invention. The RIP system 20 includes a processing unit 30, an interpreter 32, and a color combiner 34. The processing unit 30, among other things, receives the input data from the input device 22 and controls processes implemented by the interpreter 32 and the color combiner 34. The interpreter 32 converts the input data describing an image that is composed of "N" colorants into "N" halftoned color separations as is well known in the art. If certain conditions are met, as will be described below, the color combiner 34 converts the N halftoned color separations into "M" halftoned color separations, where N is typically greater than or equal to M but can have any relationship. Essentially, the color combiner 34 maps the N halftoned color separations into the specific M halftoned color separations that a user selected one of a plurality of output devices is capable of imaging. Accordingly, the M halftoned color separations are eventually fed to the output device 24. The RIP system 20 also includes an internal database (not shown) and/or interfaces an external database 36 for storing information that is necessary to convert the input data into the appropriate M halftoned color separations that the selected output device is capable of imaging.

Although depicted as discrete blocks, it will be appreciated by those skilled in the art and others that the interpreter and color combiner blocks 32 and 34 are merely representative of application processes performed by software which is controlled by the processing unit 30.

FIGURE 3 depicts the logic implemented by the RIP system 20 to produce halftoned color separations that are ideally suited for a specific output imaging device. First, at a step 40, the number of colorants, "N", in the image described by the input data is identified by the RIP system 20. Then, the particular output device selected by a user and the number of color separations, "M", that the output device is capable of imaging are identified by the RIP system 20 at a step 42. This information is identified by software running on the processing unit 30. Preferably, the RIP system 20 identifies the number of color separations, "M", that the output device is capable of imaging specifically by referencing the database 36.

Next, a test is made at a step 44 to determine whether there exists a direct mapping between the N color separations produced by the interpreter and the M color separations that the output device is capable of imaging, i.e. whether each of the N colorants identified by the original input data are included in the set of M colorants represented by the M halftoned color separations that the selected output device is capable of imaging. If the answer to the test at step 44 is no, meaning that at least one of the colorants described by the input data is not itself presently imageable by the output device, the input data describing the image having N colorants is rasterized by the interpreter 32 at a step 46. The interpreter 32 produces a separate halftoned color separation for each of the N colorants in the original image. As a result, the interpreter 32 outputs N halftoned color separations. These halftoned color separations are essentially 1 bit per pixel bitmaps, where each pixel either has a value of 1 or 0 indicating that a pixel is either turned on or off. At a step 48, the N halftoned color separations are filtered and the resulting filtered halftoned color separations are merged by the color combiner 34 to produce M color separations that are ideally suited for the selected output device 24, as will be described in further detail below. The M halftoned color separations are ultimately fed to the output device for rendering an image that most accurately reflects the image as originally composed by the input device.

On the other hand, if the answer to the test at step 44 is yes, meaning that the selected output device is capable of imaging all of the colorants described in the input data as originally defined, the input data describing the image composed of the N colorants is rasterized by the interpreter 32 to produce N halftoned color separations which are then available for sending to the output device 24 for imaging. See step 56. In this case, the N halftoned color separations are not applied to the color combiner 34.

FIGURE 4 is a flow diagram illustrating the steps performed by the color combiner 34 to filter and merge the N halftoned color separations as generally described in steps 48 and 54 of FIGURE 3. Beginning with a step 60, upon receiving the N halftoned color separations from the interpreter 32, a database search is performed by the RIP system 20 to identify a set of filters to apply to each of the N halftoned color separations. In particular, the database search results in the identification of tint percentages corresponding to each of the N halftoned color separations. The tint percentages identify the percentage contribution of each color that the output device 24 is capable of imaging in each of the N halftoned color separations. Then, the filters are computed dynamically based on the tint percentages identified in the database 36.

For example, if the interpreter produces five halftoned color separation and the output device is capable of imaging four halftoned color separations, the database search identifies the percentage of each of the four colorants that are imaged by the output device in each of the five halftoned color separation. With these tint percentages, a set of four filters is applied to each of the five halftoned color separations. It will be appreciated by those skilled in the art and others that the database search for the tint percentages can be performed by the RIP system 20 at any point after steps 40 and 42.

Next, at a step 62, after the filters are dynamically computed by the processing unit 30, each set of filters is applied to its corresponding halftoned color separation produced by the interpreter 32. The filters are essentially 1 bit per pixel bitmaps and are preferably one-dimensional stochastic filters, meaning that the size of each dot is fixed but the placement is pseudo-random. Alternatively, two-dimensional stochastic filters can be used, where both the size of each dot and placement of each dot are pseudo-random. It will be further appreciated by those skilled in the art and others that the filters could be bitmaps of halftoned dots. However, this would lead to a clash between the halftoned input pattern and the halftoned filter and, thus, would result in moire or produce other artifacts which cause undesirable patterns.

The filters are applied to the N halftoned color separations by performing a bitwise "AND" combination function, as is best illustrated in an example depicted in FIGURE 6. FIGURE 6 illustrates a 3x3 halftoned color separation 90 for a spot color identified as "cherry apple red", a set of four 3x3 filters 92, 94, 96, 98, and a set of four output 3x3 halftoned color separations 100, 102, 104, 106 resulting from the

application of the bitwise "AND" combination function to the cherry apple red halftoned color separation and each of the filters. In accordance with this example, the output device is capable of imaging four halftoned color separations representing the process colors cyan, yellow, magenta, and black. Thus, the first step, as described with reference to step 60 of FIGURE 4, is to identify the percentages of cyan, yellow, magenta and black that are used to create the cherry apple red spot color. Then, cyan, yellow, magenta and black filters are dynamically created for individually applying to the cherry apple red halftoned color separation. As shown in FIGURE 6, when both the pixels in the halftoned cherry apple red color separation and the cyan filter have a "1" in the same position, the resulting cyan filtered color separation has a "1" in the corresponding position. Any other scenario results in a "0" in the corresponding position. This process is repeated for each of the yellow, magenta and black filters as shown in FIGURE 6. This process is also repeated for each of the halftoned color separations produced by the interpreter.

Returning to FIGURE 4, after the filters are applied to each of the N halftoned color separations at step 64, the output from the filters is merged in order to produce M color separations which are ideally suited for the selected output device. In particular, this merging is accomplished by a bitwise "OR" combination function that combines each of the filters associated with one of the M colors corresponding to the M color separations to produce a merged, halftoned color separation for that particular color. For example, if a cyan filter is applied to N halftoned color separations, the result is N cyan filtered halftoned color separations. Then, in accordance with this example, as shown in FIGURE 7, N cyan filtered halftoned color separations shown at blocks 110a, 110b, 110c are applied to an "OR" combining block 114. When any one of the N filtered halftoned color separations have a "1" in the same position, the "OR" combining block produces a "1" in a corresponding position in the resulting merged cyan halftoned color separation 116. If a "0" is in the same position for all of the N filtered halftoned color separation, the result is a "0" in the resulting merged cyan halftoned color separation 116. This process is repeated for each of the colorants associated with the M color separations accepted by the output device. Thus, the result is M halftoned color separations that are suited for the selected output device.

FIGURE 5 is a block diagram illustrating how the filtering and combining of the N halftoned color separations used by the interpreter are accomplished to produce the M color separations that are ideally suited for the selected output device. Each of

the blocks 70a, 70b, 70c represent one of N halftoned color separations produced by the interpreter 32. To further illustrate the above described filtering and merging of the N halftoned color separations into M halftoned color separations, the conversion process for one of the N halftoned color separations will be described since this process is simply repeated for each of the remaining N halftoned color separations.

First, taking the halftoned color separation, I_0, shown at block 70a, a set of filters $F_M(I_0)$ are applied to the halftoned color separation I_0. Each of the filters F_M corresponds to one of the colors associated with the M color separations which are accepted by the output device. Thus, as shown in FIGURE 6, if the halftoned color separation I_0 is a cherry apple red color separation and the selected output device images a maximum of four halftoned color separations representing the colors cyan, yellow, magenta and black, i.e. M=4, four filters that each correspond to one of the colors accepted by the output device are applied to the cherry apple red halftoned color separation as shown by blocks 74a, 74b, 74c. Returning to FIGURE 5, the result from filtering is a set of filtered halftoned color separations I_0O_M as shown by blocks 76a, 76b, 76c. This process is repeated for each of the halftoned color separations I_0, I_1, ... I_N shown in blocks 70a, 70b, 70c. In this regard, a set of F_M filters is applied to each of these halftoned color separations such that for each of the halftoned color separations a set of M filtered halftoned color separations are produced. Next, all of the filtered halftoned color separations corresponding to one of the M colorants that the output device is capable of imaging are merged together in an "OR" combining block. This merging process is repeated for each set of filters corresponding to one of the M colorants imaged by the output device as best shown at "OR" combining blocks 78a, 78b, 78c in FIGURE 5. These "OR" combining blocks function the same as the "OR" combining block 114 in FIGURE 7. The results from the "OR" combining blocks 78a, 78b, and 78c are M halftoned color separations, O_M, which are now suitable for receipt by the selected output device. See blocks 79a, 79b, and 79c.

With reference to FIGURES 3-7, the steps that are identified as being performed generally by the RIP system or by the interpreter and color combiner in particular are more specifically accomplished by the programming unit 30 which is programmed accordingly.

As will be readily appreciated by those skilled in the art and others, a raster image processing system formed in accordance with the invention has a number of advantages. First, where the interpreter produces more halftoned color separation

than the selected output imaging device is capable of rendering, by filtering and merging these halftoned color separations in accordance with this invention to produce the appropriate number and set of halftoned color separations for the output device, the entire output from the output imaging device can be imaged in one step, rather than in parts as would presently have to be done. Besides simplifying the imaging process by eliminating the need to handle the imaging in parts, this invention also dramatically improves the performance of the proofing process by reducing the amount of data the output device must consume before imaging. In addition, by reducing the number of colorants required to represent the image, this invention provides a cost savings.

Furthermore, by applying digital filtering to halftoned color separations and merging the filtered results to produce the appropriate set of halftoned color separations for rendering by the output device, the image produced by the selected output device most accurately reflects the original image with few, if any, negative imaging results. Finally, by automatically determining the appropriate number and set of halftoned color separations needed for a particular selected output device and thereafter filtering and combining halftoned color separations to produce the particular number and set of halftoned color separations, not only is the imaging process simplified, but the raster image processing system can be effectively utilized with many different output devices to produce the same image. This is advantageous as not all output devices can accept the same number of colorants. However, by using this invention, a user can produce the same image with different devices capable of imaging different numbers and/or types of colorants.

While the preferred embodiment of the invention has been illustrated and described, it will be appreciated that various changes can be made therein without departing from the spirit and scope of the invention. For example, while, for ease of illustration, the interpreter and color combiner are depicted as discrete blocks in FIGURE 2, it is to be understood that the functions associated with the blocks can be carried out in various ways. In particular, the functions can be implemented in software, hardware, or a combination of hardware and software. Furthermore, although the system clearly applies to a conversion process for converting one set of colorants corresponding to the N halftoned color separations to another set of colorants describing the M halftoned color separations, the conversion also applies to converting a set of colorants corresponding to the N halftoned color separations to a single grayscale halftoned color separation.

Even further, the steps 42 and 46 shown in FIGURE 3 can alternatively be performed after the interpreter rasterizes the input data to produce the N halftoned color separations. Thus, in this instance, the raster image processing system identifies the N colorants in the input data; rasterizes the input data to produce N halftoned color separations; and then identifies the selected output device and the number and type of halftoned color separations it can image and determines whether the color combiner process needs to be implemented. If the color combiner process need not be implement, the system simply outputs the rasterized data. Otherwise, the raster image processing system continues with the filtering and merging described at step 48 and in FIGURES 4-7.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A color separation merging method for receiving input data that describes an image and producing halftoned color separations that a select output device is capable of imaging, said input data including information about the colorant used to compose the image, the color separation merging method comprising:

(a) comparing the colorants used to compose the image with the colorants corresponding to the halftoned color separations that the output device is capable of imaging; and

(b) if the colorants used to compose the image are not included in the set of colorants corresponding to the halftoned color separations that the output device is capable of imaging,

(i) rasterizing the input data describing the image to produce a number of halftoned color separations equivalent to the number of colorants used to compose the image;

(ii) merging the halftoned color separations to produce at least one merged halftoned color separation, wherein the at least one merged color separation is equivalent to the number and set of halftoned color separations that the output device is capable of imaging; and

(iii) outputting the at least one merged color separation for use by the output device.

2. The color separation merging method as claimed in Claim 1 further comprising:

if the colorants used to compose the image are included in the set of colorants corresponding to the halftoned color separations that the output device is capable of imaging,

(i) rasterizing the input data describing the image to produce a number of halftoned color separations equivalent to the number of colorants used to compose the image; and

(ii) outputting the halftoned color separations for use by the output device.

3. The color separation merging method as claimed in Claim 1, wherein merging the halftoned color separations to produce the at least one merged halftoned color separation comprises:

(a) filtering the halftoned color separations to produce filtered halftoned color separations; and

(b) combining select filtered halftoned color separations to produce at least one merged halftoned color separation.

4. The color separation merging method of Claim 3, wherein filtering the halftoned color separations to produce filtered halftoned color separations comprises:

filtering each of the halftoned color separations with at least one filter to produce at least one filtered halftoned color separation for each halftoned color separation, each of said at least one filter based upon the percentage of an output device colorant used to compose the colorant represented by the halftoned color separation.

5. The color separation merging method of Claim 4, wherein the at least one filter is a one-dimensional stochastic filter.

6. The color separation merging method of Claim 4, wherein the at least one filter is a two-dimensional stochastic filter.

7. The color separation merging method of Claim 4, wherein the combining of the select filtered halftoned color separations to produce at least one merged halftoned color separation comprises:

(a) combining the filtered halftoned color separations that were filtered based on a first of the output device colorants to produce a merged halftoned color separation for the first output device colorant; and

(b) repeating set (a) for each of the output device colorants.

AMENDED CLAIMS

[received by the International Bureau on 02 February 2001 (02.02.01); original claims 1-17replaced by new claims 8-61 (14 pages)]

8. A color separation merging method for receiving input data that describes an image and producing halftoned color separations that a select output device is capable of imaging, said input data including information about the colorants used to compose the image, the method comprising:

(a) comparing the colorants used to compose the image with the colorants that the output device is capable of imaging; and

(b) if the colorants used to compose the image are not included in the set of colorants that the output device is capable of imaging,

(i) rasterizing the input data describing the image to produce a number of halftoned color separations corresponding in number and color to the colorants used to compose the image;

(ii) filtering the resulting halftoned color separations to produce filtered halftoned color separations;

(iii) combining select filtered halftoned color separations to produce a number of merged halftoned color separations corresponding in number and color to the halftoned color separations that the output device is capable of imaging; and

(iv) outputting the resulting merged halftoned color separations for use by the output device.

9. The color separation merging method of Claim 8 further comprising:

if the colorants used to compose the image are included in the set of colorants that the output device is capable of imaging;

(i) rasterizing the input data describing the image to produce a number of halftoned color separations corresponding in number and color to the colorants used to compose the image; and

(ii) outputting the resulting halftoned color separations for use by the output device.

10. The color separation merging method of Claim 8, wherein filtering the halftoned color separations to produce filtered halftoned color separations comprises:

applying a set of filters to each of the halftoned color separations, each set of filters corresponding in number and color to the colorants that the output device is capable of imaging, each filter in the set based upon a tint percentage identifying the percent contribution of a colorant that the output device is capable of imaging in the halftoned color separation to be filtered.

11. The color separation merging method of Claim 10, wherein the filters are applied by performing a bitwise "AND" combination function on the halftoned color separations with the filters.

12. The color separation merging method of Claim 10, wherein the combining of the select filtered halftoned color separations to produce a number of merged halftoned color separations comprises:

(a) combining the filtered halftoned color separations that were filtered with a filter corresponding to a first of the output device colorants to produce a merged halftoned color separation for the first output device colorant; and

(b) repeating step (a) for each additional output device colorant, if any.

13. The color separation merging method of Claim 12, wherein the filtered halftoned color separations are combined by:

(a) performing a bitwise "OR" combination function on all of the filtered halftoned color separations corresponding to a first output device colorant; and

(b) repeating step (a) for each additional output device colorant, if any.

14. The color separation merging method of Claim 13, wherein each of the filters is a one-dimensional stochastic filter.

15. The color separation merging method of Claim 13, wherein each of the filters is a two-dimensional stochastic filter.

16. A method for receiving input data that describes an image and producing halftoned color separations that a select output device is capable of imaging, said input data including information about the colorants used to compute the image and said select output device capable of producing an image with a set of output device colorants, the method comprising:

(a) rasterizing the input data describing the image to produce a number of halftoned color separations corresponding in number and color to the colorants used to compose the image;

(b) comparing the colorants used to compose the image with the output device colorants;

(c) if the colorants used to compose the image are not included in the set of output device colorants,

(i) filtering the halftoned color separations to produce filtered halftoned color separations;

(ii) combining the filtered halftoned color separations corresponding to a first of the output device colorants to produce a merged halftoned color separation;

(iii) repeating step (ii) for each additional output device colorant, if any; and

(iv) outputting the resulting merged halftoned color separations for use by the output device.

17. The method of Claim 16 further comprising:

if the colorants used to compose the image are included in the set of output device colorants, outputting the halftoned color separations for use by the output device.

18. The method of Claim 16, wherein filtering the halftoned color separations to produce filtered halftoned color separations comprises:

(a) identifying a set of filters to apply to each of the halftoned color separations by:

(i) identifying a tint percentage indicating the percent contribution of each output device colorant in each of the halftoned color separations; and

(ii) dynamically computing the filters based on the tint percentages; and

(b) applying each set of filters to the corresponding halftoned color separation.

19. The method of Claim 18, wherein applying each set of filters to the corresponding halftoned color separation comprises performing a bitwise "AND" combination function on the halftoned color separation with each of the filters from the corresponding set.

20. The method of Claim 19, wherein combining the filtered halftoned color separations to produce merged halftoned color separations suitable for the select output device comprises:

(a) performing a bitwise "OR" combination function on the filtered halftoned color separations corresponding to a first of the output device colorants to

produce a merged halftoned color separation corresponding to the first output device colorant: and

(b) repeating step (a) for each additional output device colorant, if any.

21. A method for receiving input data that describes an image and producing halftoned color separations that a select output device is capable of imaging, said input data including information about the colorants used to compute the image and said select output device capable of producing an image with a set of output device colorants, the method comprising:

(a) rasterizing the input data describing the image to produce a number of halftoned color separations corresponding in number and color to the colorants used to compose the image;

(b) comparing the colorants used to compose the image with the output device colorants;

(c) if the colorants used to compose the image are not included in the set of output device colorants,

(i) filtering the halftoned color separations to produce filtered halftoned color separations; and

(ii) combining the filtered halftoned color separations to produce a number of merged halftoned color separations suitable for the select output device.

22. The method of Claim 21, wherein combining the filtered halftoned color separations to produce a number of merged halftoned color separations suitable for the select output device comprises:

(i) combining the filtered halftoned color separations corresponding to a first of the output device colorants to produce a merged halftoned color separation corresponding to the first output device colorant; and

(ii) repeating step (i) for each additional output device colorant, if any, to produce a merged halftoned color separation for each additional output device colorant.

23. The method of Claim 21, wherein combining the filtered halftoned color separations to produce merged halftoned color separations suitable for the select output device comprises:

(a) performing a bitwise "OR" combination function on the filtered halftoned color separations corresponding to a first of the output device colorants to

produce a merged halftoned color separation corresponding to the first output device colorant; and

(b) repeating step (a) for each additional output device colorant, if any.

24. The method of Claim 23, wherein filtering the halftoned color separations to produce filtered halftoned color separations comprises:

(a) identifying a set of filters to apply to each of the halftoned color separations by:

(i) identifying a tint percentage indicating the percent contribution of each output device colorant in each of the halftoned color separations; and

(ii) dynamically computing the filters based on the tint percentages; and

(b) applying each set of filters to the corresponding halftoned color separation.

25. The method of Claim 24, wherein applying each set of filters to the corresponding halftoned color separation comprises performing a bitwise "AND" combination function on the halftoned color separation with each of the filters from the corresponding set.

26. A system for receiving input data that describes an image and producing halftoned color separations that a select output device is capable of imaging, said input data including information about the colorants used to compose the image, the system comprising:

(a) means for comparing the colorants used to compose the image with the colorants that the output device is capable of imaging; and

(b) means for processing the input data if the colorants used to compose the image are not included in the set of colorants that the output device is capable of imaging, said processing means including:

(i) means for rasterizing the input data describing the image to produce a number of halftoned color separations corresponding in number and color to the colorants used to compose the image;

(ii) means for filtering the resulting halftoned color separations to produce filtered halftoned color separations;

(iii) means for combining select filtered halftoned color separations to produce a number of merged halftoned color separations corresponding in number

and color to the halftoned color separations that the output device is capable of imaging; and

(iv) means for outputting the resulting merged halftoned color separations for use by the output device.

27. The system of Claim 26 further comprising:

additional processing means for processing the input data if the colorants used to compose the image are included in the set of colorants that the output device is capable of imaging, said additional processing means including:

(i) means for rasterizing the input data describing the image to produce a number of halftoned color separations corresponding in number and color to the colorants used to compose the image; and

(ii) means for outputting the resulting halftoned color separations for use by the output device.

28. The system of Claim 26, wherein the means for filtering the halftoned color separations to produce filtered halftoned color separations comprises:

means for applying a set of filters to each of the halftoned color separations, each set of filters corresponding in number and color to the colorants that the output device is capable of imaging, each filter in the set based upon a tint percentage identifying the percent contribution of a colorant that the output device is capable of imaging in the halftoned color separation to be filtered.

29. The system of Claim 28, wherein the filters are applied by performing a bitwise "AND" combination function on the halftoned color separations with the filters.

30. The system Claim 28, wherein the means for combining of the select filtered halftoned color separations to produce a number of merged halftoned color separations comprises:

(a) means for combining the filtered halftoned color separations that were filtered with a filter corresponding to a first of the output device colorants to produce a merged halftoned color separation for the first output device colorant; and

(b) means for repeating step (a) for each additional output device colorant. if any.

31. The system of Claim 30, wherein the filtered halftoned color separations are combined by:

(a) performing a bitwise "OR" combination function on all of the filtered halftoned color separations corresponding to a first output device colorant; and

(b) repeating step (a) for each additional output device colorant, if any.

32. The system of Claim 31, wherein each of the filters is a one-dimensional stochastic filter.

33. The system of Claim 31, wherein each of the filters is a two-dimensional stochastic filter.

34. A system for receiving input data that describes an image and producing halftoned color separations that a select output device is capable of imaging, said input data including information about the colorants used to compute the image and said select output device capable of producing an image with a set of output device colorants, the system comprising:

(a) means for rasterizing the input data describing the image to produce a number of halftoned color separations corresponding in number and color to the colorants used to compose the image;

(b) means for comparing the colorants used to compose the image with the output device colorants;

(c) means for processing the input data if the colorants used to compose the image are not included in the set of output device colorants, said processing means comprising:

(i) means for filtering the halftoned color separations to produce filtered halftoned color separations;

(ii) means for combining the filtered halftoned color separations corresponding to a first of the output device colorants to produce a merged halftoned color separation;

(iii) means for repeating step (ii) for each additional output device colorant, if any; and

(iv) means for outputting the resulting merged halftoned color separations for use by the output device.

35. The system of Claim 34 further comprising:

means for outputting the halftoned color separations produced by the rasterizing means if the colorants used to compose the image are included in the set of output device colorants.

36. The system of Claim 34, wherein the means for filtering the halftoned color separations to produce filtered halftoned color separations comprises:

(a) means for identifying a set of filters to apply to each of the halftoned color separations by:

(i) identifying a tint percentage indicating the percent contribution of each output device colorant in each of the halftoned color separations; and

(ii) dynamically computing the filters based on the tint percentages; and

(b) means for applying each set of filters to the corresponding halftoned color separation.

37. The system of Claim 36, wherein the means for applying each set of filters to the corresponding halftoned color separation comprises means for performing a bitwise "AND" combination function on the halftoned color separation with each of the filters from the corresponding set.

38. The system of Claim 37, wherein the means for combining the filtered halftoned color separations to produce merged halftoned color separations suitable for the select output device comprises:

(a) means for performing a bitwise "OR" combination function on the filtered halftoned color separations corresponding to a first of the output device colorants to produce a merged halftoned color separation corresponding to the first output device colorant; and

(b) means for repeating step (a) for each additional output device colorant, if any.

39. A system for receiving input data that describes an image and producing halftoned color separations that a select output device is capable of imaging, said input data including information about the colorants used to compute the image and said select output device capable of producing an image with a set of output device colorants, the system comprising:

(a) means for rasterizing the input data describing the image to produce a number of halftoned color separations corresponding in number and color to the colorants used to compose the image;

(b) means for comparing the colorants used to compose the image with the output device colorants;

(c) means for processing the input data if the colorants used to compose the image are not included in the set of output device colorants, said processing means comprising:

(i) means for filtering the halftoned color separations to produce filtered halftoned color separations; and

(ii) means for combining the filtered halftoned color separations to produce a number of merged halftoned color separations suitable for the select output device.

40. The system of Claim 39, wherein the means for combining the filtered halftoned color separations to produce a number of merged halftoned color separations suitable for the select output device comprises:

(i) means for combining the filtered halftoned color separations corresponding to a first of the output device colorants to produce a merged halftoned color separation corresponding to the first output device colorant; and

(ii) means for repeating step (i) for each additional output device colorant, if any, to produce a merged halftoned color separation for each additional output device colorant.

41. The system of Claim 39, wherein the means for combining the filtered halftoned color separations to produce merged halftoned color separations suitable for the select output device comprises:

(a) means for performing a bitwise "OR" combination function on the filtered halftoned color separations corresponding to a first of the output device colorants to produce a merged halftoned color separation corresponding to the first output device colorant; and

(b) means for repeating step (a) for each additional output device colorant, if any.

42. The system of Claim 41, wherein the means for filtering the halftoned color separations to produce filtered halftoned color separations comprises:

(a) identifying a set of filters to apply to each of the halftoned color separations by:

(i) for identifying a tint percentage indicating the percent contribution of each output device colorant in each of the halftoned color separations; and

(ii) for dynamically computing the filters based on the tint percentages; and

(b) means for applying each set of filters to the corresponding halftoned color separation.

43. The system of Claim 42, wherein the means for applying each set of filters to the corresponding halftoned color separation comprises means for performing a bitwise "AND" combination function on the halftoned color separation with each of the filters from the corresponding set.

44. An apparatus for receiving input data that describes an image and producing halftoned color separations that a select output device is capable of imaging, said input data including information about the colorants used to compose the image, wherein the apparatus is operative to:

(a) compare the colorants used to compose the image with the colorants that the output device is capable of imaging; and

(b) if the colorants used to compose the image are not included in the set of colorants that the output device is capable of imaging,

(i) rasterize the input data describing the image to produce a number of halftoned color separations corresponding in number and color to the colorants used to compose the image;

(ii) filter the resulting halftoned color separations to produce filtered halftoned color separations;

(iii) combine select filtered halftoned color separations to produce a number of merged halftoned color separations corresponding in number and color to the halftoned color separations that the output device is capable of imaging; and

(iv) output the resulting merged halftoned color separations for use by the output device.

45. The apparatus of Claim 44 further operative to:

if the colorants used to compose the image are included in the set of colorants that the output device is capable of imaging;

(i) rasterize the input data describing the image to produce a number of halftoned color separations corresponding in number and color to the colorants used to compose the image; and

(ii) output the resulting halftoned color separations for use by the output device.

46. The apparatus of Claim 44, wherein filtering the halftoned color separations to produce filtered halftoned color separations comprises:

applying a set of filters to each of the halftoned color separations, each set of filters corresponding in number and color to the colorants that the output device is capable of imaging, each filter in the set based upon a tint percentage identifying the percent contribution of a colorant that the output device is capable of imaging in the halftoned color separation to be filtered.

47. The apparatus of Claim 46, wherein the filters are applied by performing a bitwise "AND" combination function on the halftoned color separations with the filters.

48. The apparatus of Claim 46, wherein the combining of the select filtered halftoned color separations to produce a number of merged halftoned color separations comprises:

(a) combining the filtered halftoned color separations that were filtered with a filter corresponding to a first of the output device colorants to produce a merged halftoned color separation for the first output device colorant; and

(b) repeating step (a) for each additional output device colorant, if any.

49. The apparatus of Claim 48, wherein the filtered halftoned color separations are combined by:

(a) performing a bitwise "OR" combination function on all of the filtered halftoned color separations corresponding to a first output device colorant; and

(b) repeating step (a) for each additional output device colorant, if any.

50. The apparatus of Claim 49, wherein each of the filters is a one-dimensional stochastic filter.

51. The apparatus of Claim 49, wherein each of the filters is a two-dimensional stochastic filter.

52. An apparatus for receiving input data that describes an image and producing halftoned color separations that a select output device is capable of imaging, said input data including information about the colorants used to compute the image and said select output device capable of producing an image with a set of output device colorants, wherein the apparatus is operative to:

(a) rasterize the input data describing the image to produce a number of halftoned color separations corresponding in number and color to the colorants used to compose the image;

(b) compare the colorants used to compose the image with the output device colorants;

(c) if the colorants used to compose the image are not included in the set of output device colorants,

(i) filter the halftoned color separations to produce filtered halftoned color separations;

(ii) combine the filtered halftoned color separations corresponding to a first of the output device colorants to produce a merged halftoned color separation;

(iii) repeat step (ii) for each additional output device colorant, if any; and

(iv) output the resulting merged halftoned color separations for use by the output device.

53. The apparatus of Claim 52 further operative to:

if the colorants used to compose the image are included in the set of output device colorants, output the halftoned color separations for use by the output device.

54. The apparatus of Claim 52, wherein filtering the halftoned color separations to produce filtered halftoned color separations comprises:

(a) identifying a set of filters to apply to each of the halftoned color separations by:

(i) identifying a tint percentage indicating the percent contribution of each output device colorant in each of the halftoned color separations; and

(ii) dynamically computing the filters based on the tint percentages; and

(b) applying each set of filters to the corresponding halftoned color separation.

55. The apparatus of Claim 54, wherein applying each set of filters to the corresponding halftoned color separation comprises performing a bitwise "AND" combination function on the halftoned color separation with each of the filters from the corresponding set.

56. The apparatus of Claim 55, wherein combining the filtered halftoned color separations to produce merged halftoned color separations suitable for the select output device comprises:

(a) performing a bitwise "OR" combination function on the filtered halftoned color separations corresponding to a first of the output device colorants to produce a merged halftoned color separation corresponding to the first output device colorant; and

(b) repeating step (a) for each additional output device colorant, if any.

57. An apparatus for receiving input data that describes an image and producing halftoned color separations that a select output device is capable of imaging, said input data including information about the colorants used to compute the image and said select output device capable of producing an image with a set of output device colorants, wherein the apparatus is operative to:

(a) rasterize the input data describing the image to produce a number of halftoned color separations corresponding in number and color to the colorants used to compose the image;

(b) compare the colorants used to compose the image with the output device colorants;

(c) if the colorants used to compose the image are not included in the set of output device colorants,

(i) filter the halftoned color separations to produce filtered halftoned color separations; and

(ii) combine the filtered halftoned color separations to produce a number of merged halftoned color separations suitable for the select output device.

58. The apparatus of Claim 57, wherein combining the filtered halftoned color separations to produce a number of merged halftoned color separations suitable for the select output device comprises:

(i) combining the filtered halftoned color separations corresponding to a first of the output device colorants to produce a merged halftoned color separation corresponding to the first output device colorant; and

(ii) repeating step (i) for each additional output device colorant, if any, to produce a merged halftoned color separation for each additional output device colorant.

59. The apparatus of Claim 57, wherein combining the filtered halftoned color separations to produce merged halftoned color separations suitable for the select output device comprises:

(a) performing a bitwise "OR" combination function on the filtered halftoned color separations corresponding to a first of the output device colorants to produce a merged halftoned color separation corresponding to the first output device colorant; and

(b) repeating step (a) for each additional output device colorant, if any.

60. The apparatus of Claim 59, wherein filtering the halftoned color separations to produce filtered halftoned color separations comprises:

(a) identifying a set of filters to apply to each of the halftoned color separations by:

(i) identifying a tint percentage indicating the percent contribution of each output device colorant in each of the halftoned color separations; and

(ii) dynamically computing the filters based on the tint percentages; and

(b) applying each set of filters to the corresponding halftoned color separation.

61. The apparatus of Claim 60, wherein applying each set of filters to the corresponding halftoned color separation comprises performing a bitwise "AND" combination function on the halftoned color separation with each of the filters from the corresponding set.

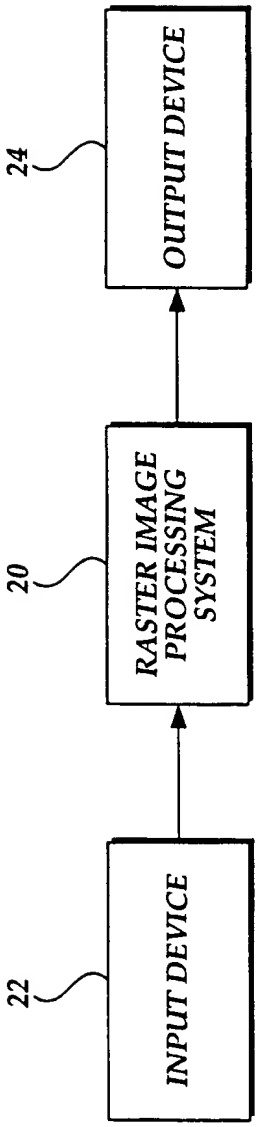
OUTPUT DEVICE
24
RASTER IMAGE PROCESSING SYSTEM
20
INPUT DEVICE
22

Fig.1.

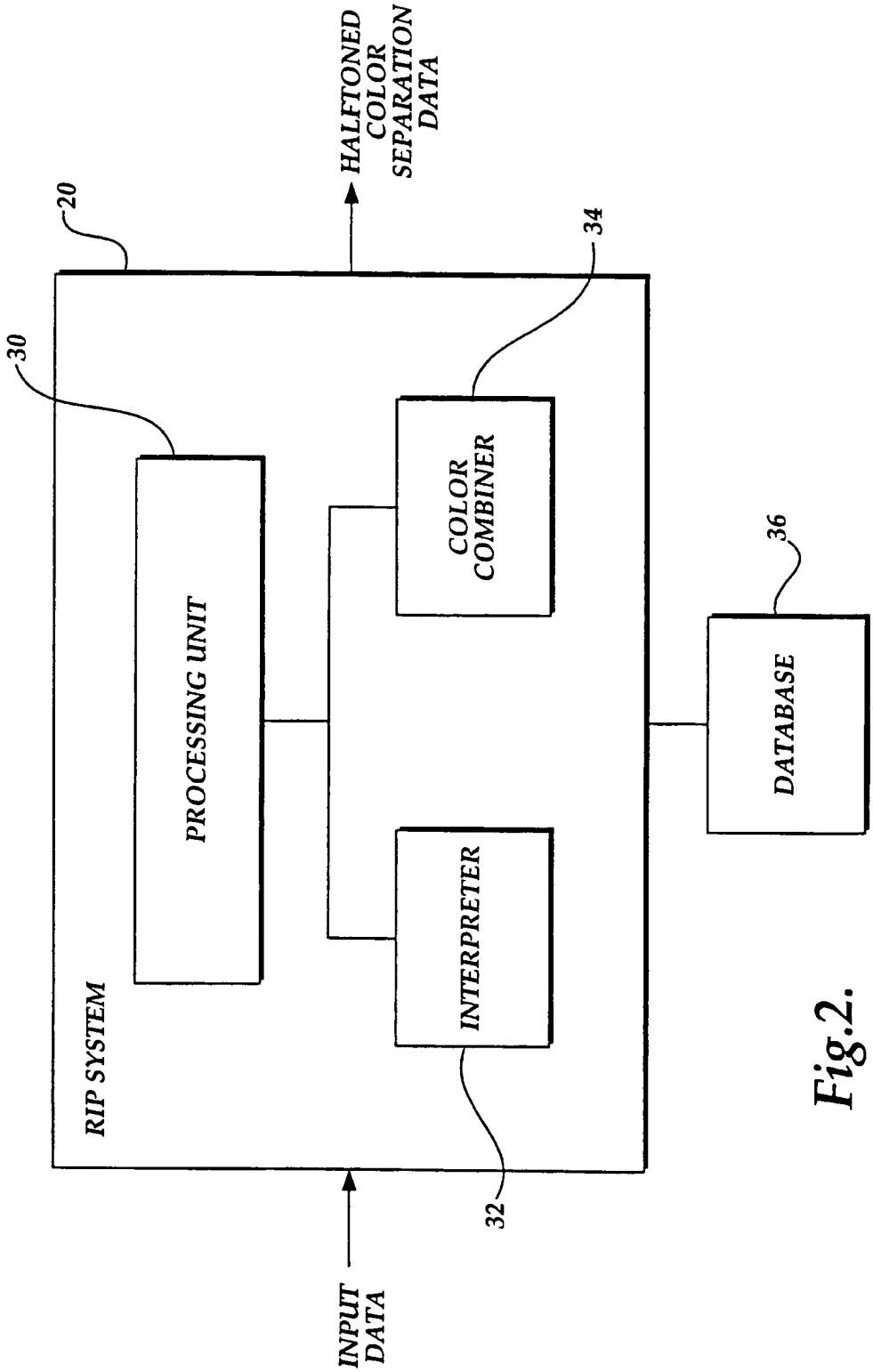
HALFTONED COLOR SEPARATION DATA
20
34
30
COLOR COMBINER
PROCESSING UNIT
36
DATABASE
INTERPRETER
RIP SYSTEM
32
INPUT DATA

Fig.2.

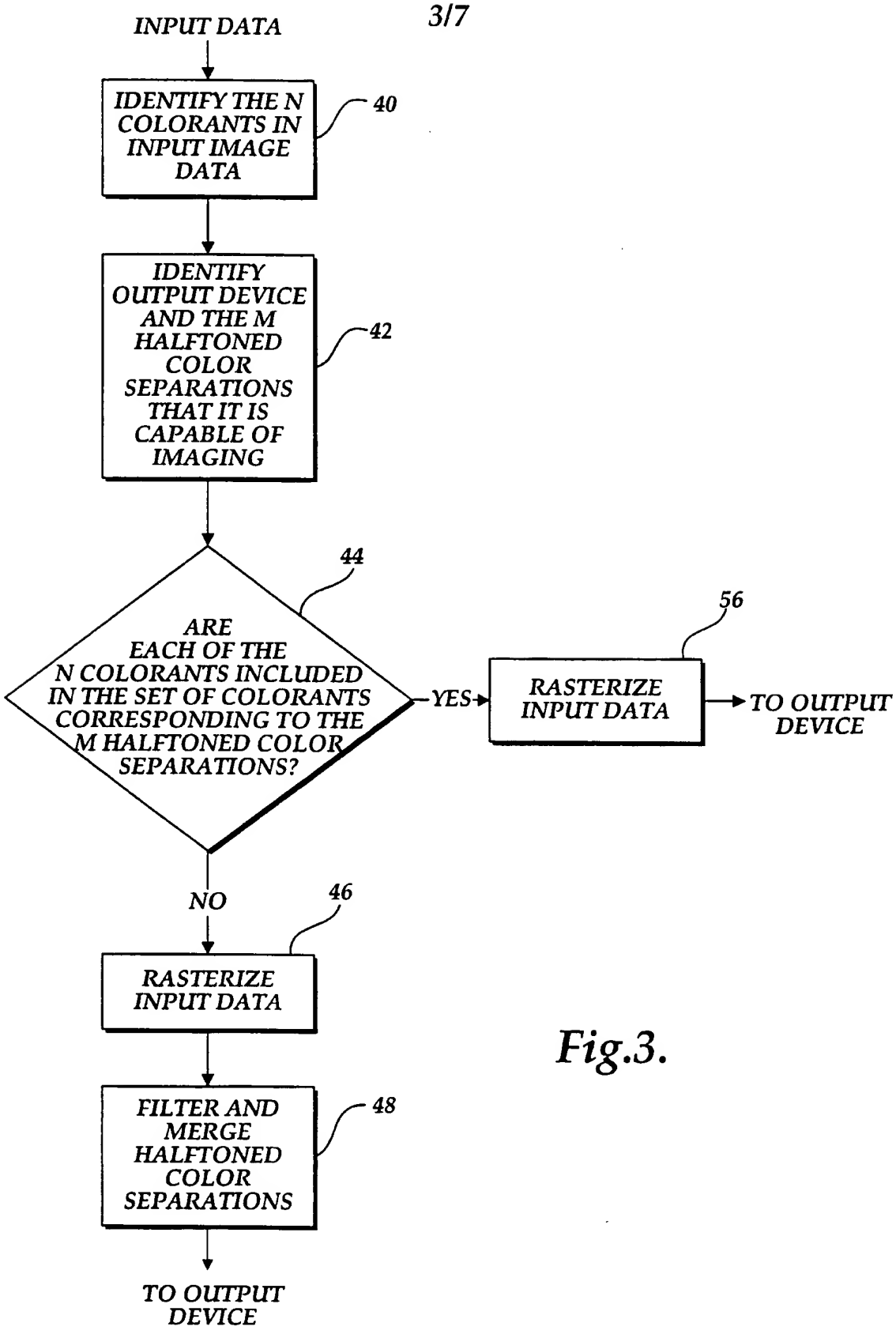
INPUT DATA
IDENTIFY THE N COLORANTS IN INPUT IMAGE DATA
40
IDENTIFY OUTPUT DEVICE AND THE M HALFTONED COLOR SEPARATIONS THAT IT IS CAPABLE OF IMAGING
42
44
ARE EACH OF THE N COLORANTS INCLUDED IN THE SET OF COLORANTS CORRESPONDING TO THE M HALFTONED COLOR SEPARATIONS?
YES
56
RASTERIZE INPUT DATA
TO OUTPUT DEVICE
NO
46
RASTERIZE INPUT DATA
FILTER AND MERGE HALFTONED COLOR SEPARATIONS
48
TO OUTPUT DEVICE

Fig.3.

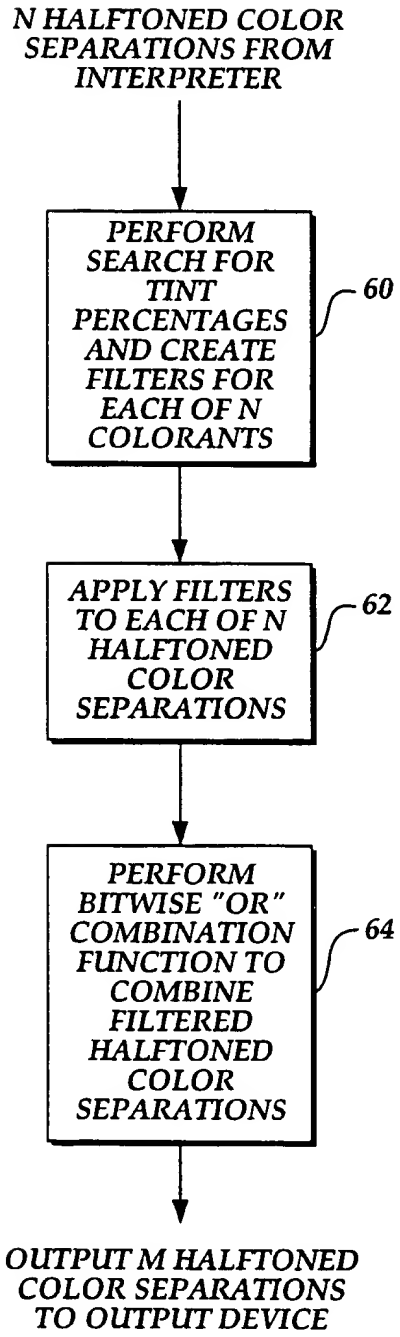
N HALFTONED COLOR SEPARATIONS FROM INTERPRETER
PERFORM SEARCH FOR TINT PERCENTAGES AND CREATE FILTERS FOR EACH OF N COLORANTS
60
APPLY FILTERS TO EACH OF N HALFTONED COLOR SEPARATIONS
62
PERFORM BITWISE "OR" COMBINATION FUNCTION TO COMBINE FILTERED HALFTONED COLOR SEPARATIONS
64
OUTPUT M HALFTONED COLOR SEPARATIONS TO OUTPUT DEVICE

Fig.4.

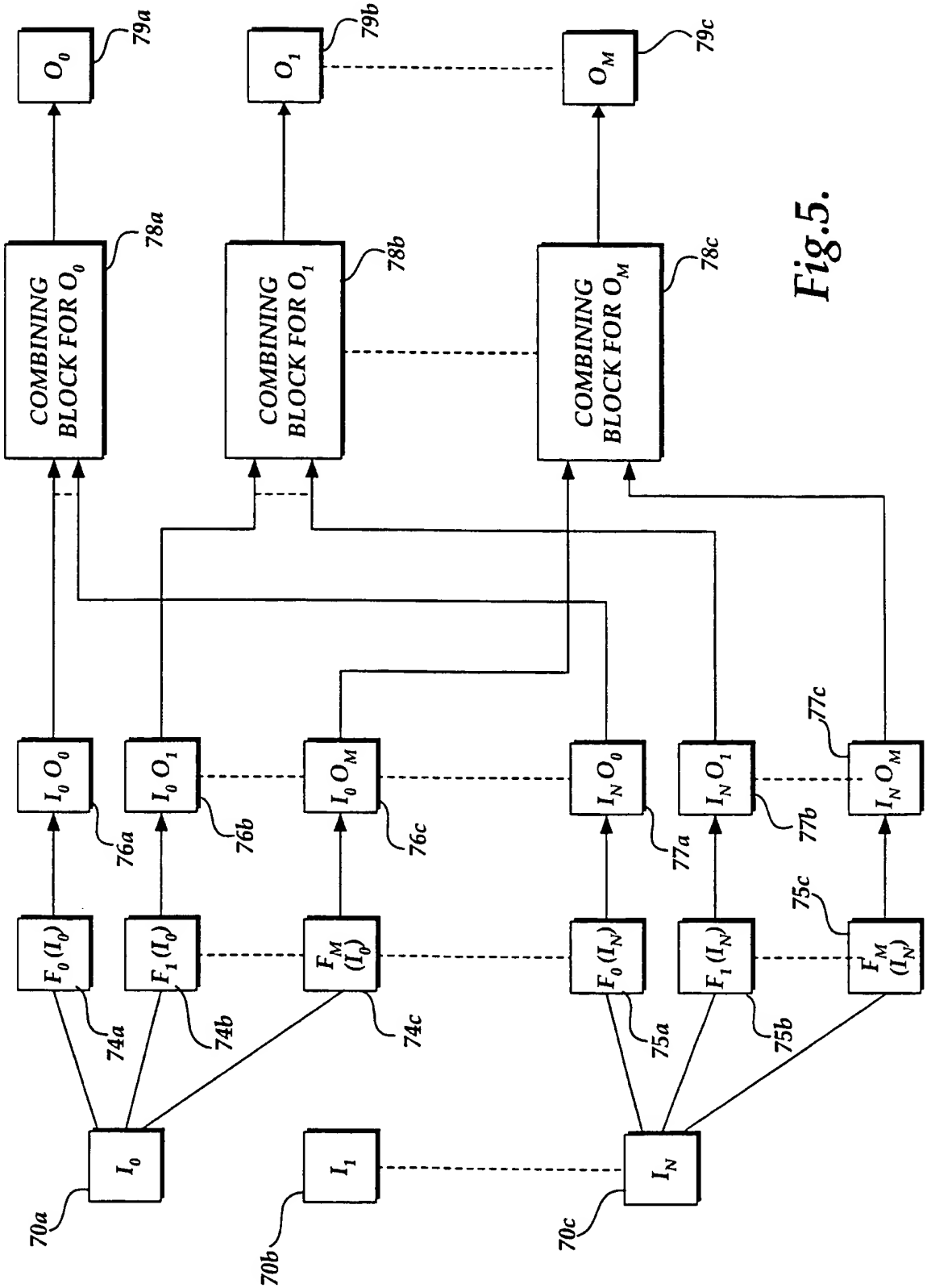
O_0
79a
O_1
79b
O_M
79c
COMBINING BLOCK FOR O_0
78a
COMBINING BLOCK FOR O_1
78b
COMBINING BLOCK FOR O_M
78c
I_0 O_0
76a
I_0 O_1
76b
I_0 O_M
76c
I_N O_0
77a
I_N O_1
77b
I_N O_M
77c
$F_0(I_0)$
74a
$F_1(I_0)$
74b
$F_M(I_0)$
74c
$F_0(I_N)$
75a
$F_1(I_N)$
75b
$F_M(I_N)$
75c
I_0
70a
I_1
70b
I_N
70c

Fig.5.

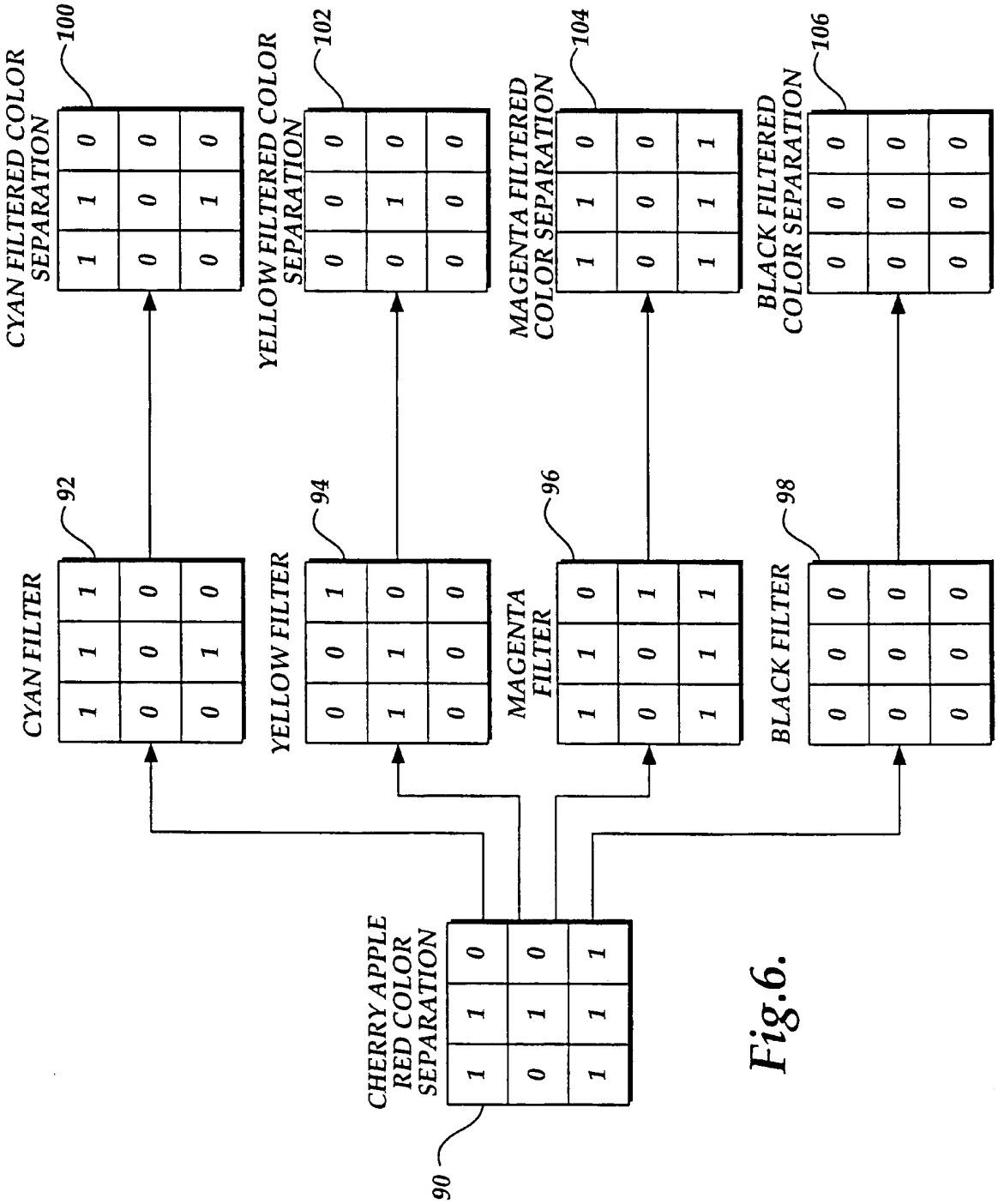
CYAN FILTERED COLOR SEPARATION
100
YELLOW FILTERED COLOR SEPARATION
102
MAGENTA FILTERED COLOR SEPARATION
104
BLACK FILTERED COLOR SEPARATION
106
CYAN FILTER
92
YELLOW FILTER
94
MAGENTA FILTER
96
BLACK FILTER
98
CHERRY APPLE RED COLOR SEPARATION
90

Fig.6.

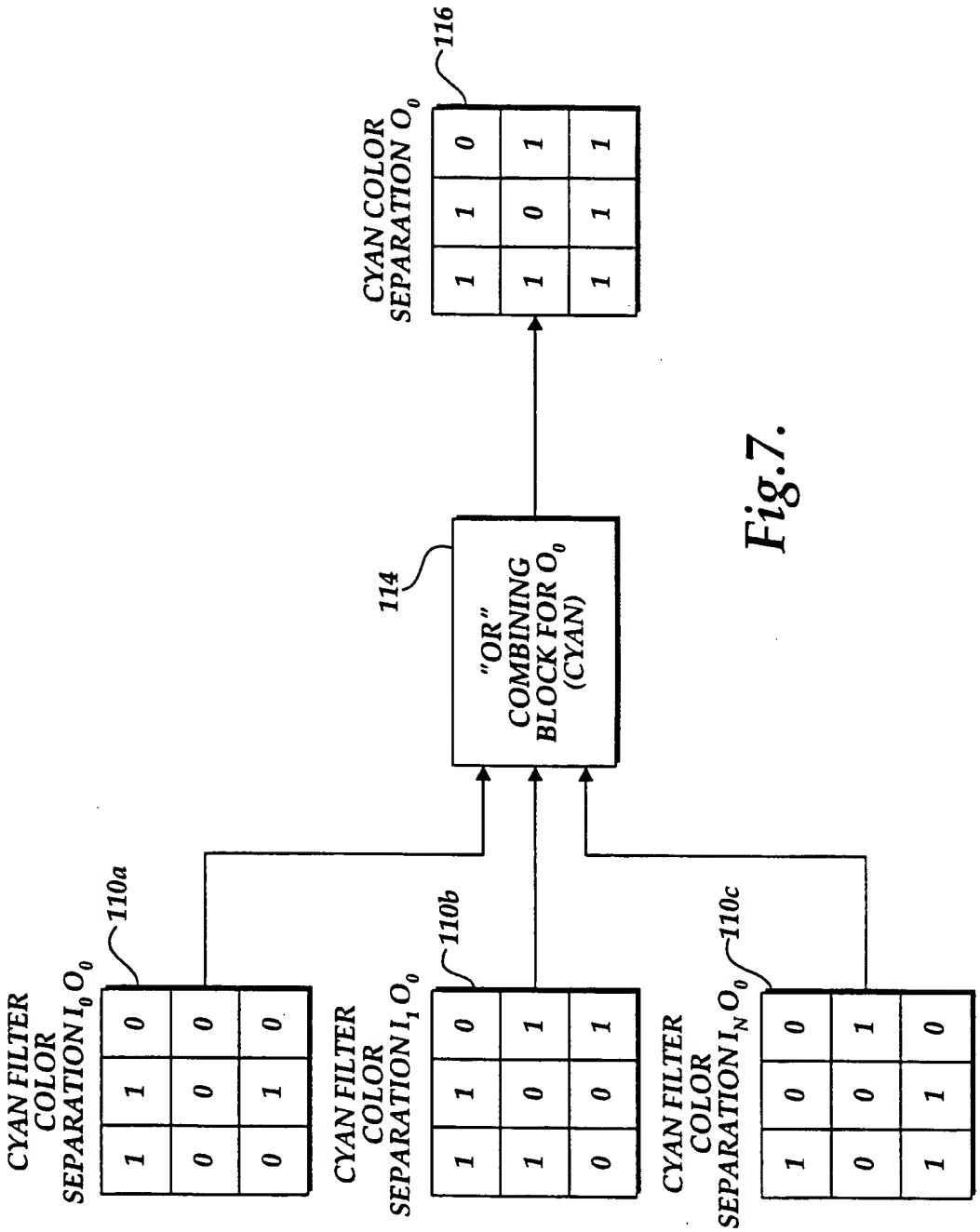
CYAN FILTER COLOR SEPARATION I_0 O_0
110a
CYAN FILTER COLOR SEPARATION I_1 O_0
110b
CYAN FILTER COLOR SEPARATION I_N O_0
110c
"OR" COMBINING BLOCK FOR O_0 (CYAN)
114
CYAN COLOR SEPARATION O_0
116

Fig.7.

INTERNATIONAL SEARCH REPORT

Inten ›nal Application No
PCT/US 00/23838

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H04N1/46

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H04N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	EP 0 790 548 A (LEXMARK INT INC) 20 August 1997 (1997-08-20) abstract; figures 1-3 column 2, line 42 -column 3, line 3	1
Y	US 5 845 056 A (KOEHLER THOMAS ET AL) 1 December 1998 (1998-12-01) abstract; figure 1	1
A	US 5 553 171 A (LIN YING-WEI ET AL) 3 September 1996 (1996-09-03) abstract	3,4
A	US 4 955 065 A (ULICHNEY ROBERT A) 4 September 1990 (1990-09-04) abstract; figure 1	5,6

-/--

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
20 November 2000	04/12/2000

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Kassow, H

1

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Inter. ɔnal Application No
PCT/US 00/23838

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0 533 593 A (EASTMAN KODAK CO) 24 March 1993 (1993-03-24)	
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